4 wheel steering. (4WS)

4ws Writeup - Kevin (sean1121) Oct. 13th 2006

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DISCLAIMER:
I personally love 4ws, I think it makes the car more responsive and fun to drive. If you don't like it that's great.

Note: This is mainly about the USDM 4th gen prelude 4ws system as that's what I have, I'll include info on the 3rd gen and 5th gen JDM and EDM as I see fit or as I come across it. Everything here is either from personal experiance or from reading everything I could find, if you think anything is incorrect let me know, but please have info to back it up with.

Purpose:
I'm writing this so there will be a central source of information on the USDM 4th gen 4ws system.

Why am I writing this?
I'm sick and tired of seeing people answer questions about 4ws with totally incorrect info. On almost every prelude forum when someone asks about 4ws they get answers that are totally incorrect, probably from people who have never owned or even driven a 4ws prelude. After sifting through all that crap while tring to complete my swap I decided that I'd try and group all the info I could find about it in one spot so here we go!

[rant]

The absolute first thing I want to address is this, the ECU has nothing to do with the 4ws system. Reread that. I'll say it again, the ECU has ****NOTHING**** to do with 4ws. If you don't believe me go check the wiring digrams, you can find them here: http://www.simnets.com/pub/cars/prelude/Wiring%20diagrams.pdf. If you still don't believe me then explain how I have an **Accord** P0F ECU in the lude and the 4ws works! This is probably the most common misconception out there relating to 4ws. So everyone out there telling peeps that they have to buy a 4ws ECU stop it, you're wrong. From what I can tell the 4W on the ECU simply means that it came out of a 4ws car. As for the 4W ECU's with 4 plugs, no idea what the 4th one is for but it's not for 4ws. Ok, now that that's cleared up lets get to it.

[/rant]

Theory of operation.

From the service manual:

Outline:
The electronically controlled power assisted 4WS (4-wheel steering system) consists of the hydraulic power steering system that steers the front wheels, the rear actuator that steers the rear wheels, the 4WS control unit, and the sensors that detect the car's speed and other steering conditions. The front steering gearbox and the rear actuator are connected by a wire harness. The rear steering angle is controlled electrically, allowing the rear wheels to be set at any designated steering angle.

System Operation:
The 4WS control unit receives input from the Vehicle Speed Sensor (VSS), front main steering angle sensor, and

the font sub steering angle sensor. The 4WS control unit calculates the vehicle speed, steering turning angle, steering speed and steering direction to determine the best angle to steer the rear wheels.

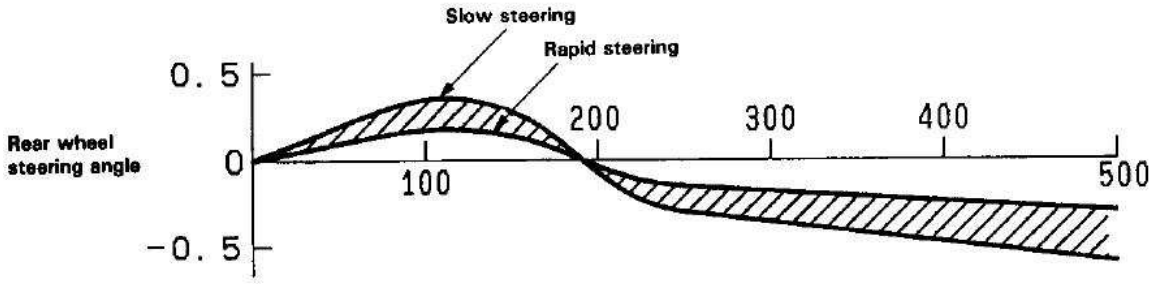
The rear wheels are turned by a motor built into the rear steering actuator. The motor is actived by the power circuit in the 4WS control unit. The actual steering angle of the rear wheels is detected by the rear main steering angle sensor, and the rear sub steering angle sensor. The 4WS control unit adjusts the angle according to the difference between the sensed steering angle of the rear wheels and the targeted steering angle of the rear wheels.

Features of rear wheel steering:
The electronically controlled power assisted 4WS sets the rear wheels at the best steering angle for the car's speed, steering rotation speed, steering wheel angle, etc.

*** Car speed**
When the car is traveling at low speed, the 4WS system turns the rear wheels in the reverse direction of the front wheels in proportion to the rotation angle of the steering wheel. When the car is traveling at higher speeds, the system increases the steering angle of the rear wheels in the same direction as the front wheels.
Changing the steering angle performance of the rear wheels in relation to the car's speed gives the car improved handling characteristics.

*** Steering speed 18 mph (30 km/h) or above**
The rear wheel steering angle varies with how rapidly the steering wheel is rotated. See graph

(Steering angle/speed performance curve)



Component Function & Operation

Rear actuator:
The rear actuator is mounted at the rear of the car to steer the rear wheels. The motor, built into the actuator, is made up of a stato with a permanent magnet, a rotor, and brushes that pass electricity to the commutators. The motor is mounted on the same axis as the steering shaft screw, making the rear actuator compact and light in weight. The rear actuator also contains the rear main steering angle sensor and the rear sub steering angle sensor. The 4WS control unit drives the electric motor with DC current. It switches the current polarity to change the motor's direction. Two strong return springs, one at each end ot the actuator, provide a centering action. They return the rear wheels to the straight-ahead position whenever current is cut to the motor.

Front main steering angle sensor:
The front main steering angle sensor is mounted in the steering column. It senses the direction and angle of steering wheel rotation and converts it to electrical signals that are sent to the 4WS control unit.

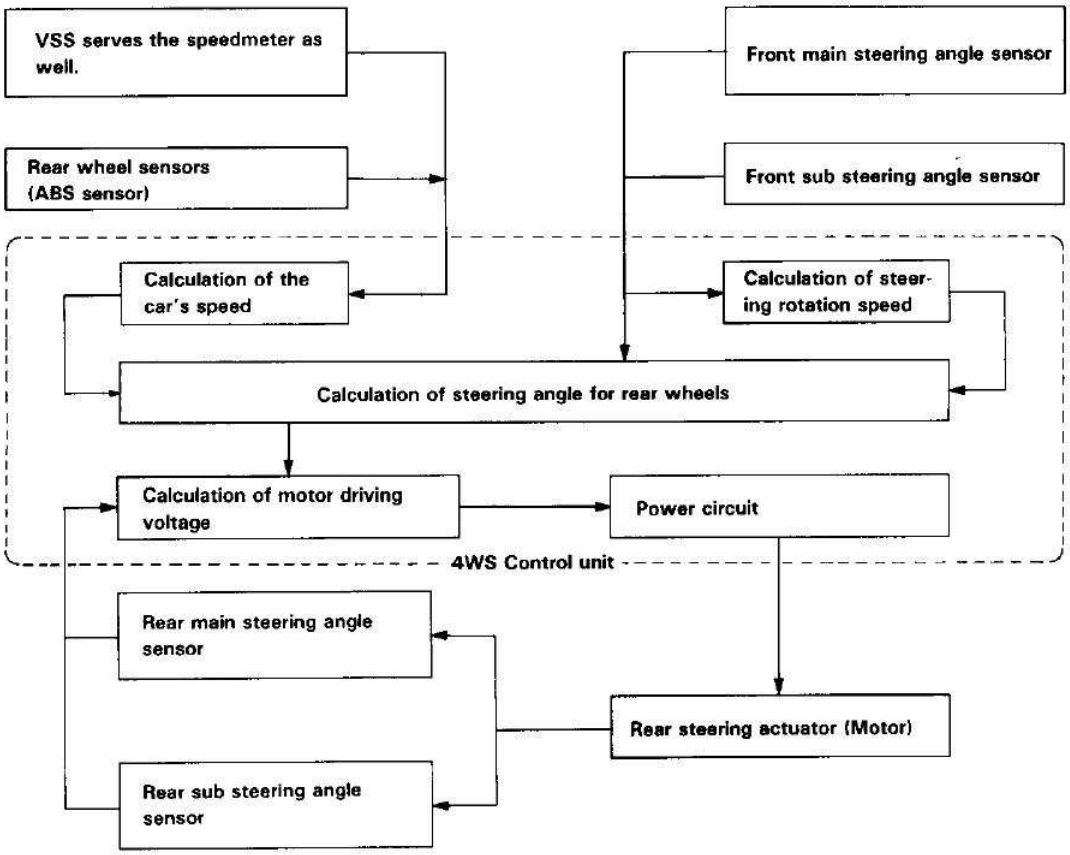
Rear main steering angle sensor:

The rear main steering angle sensor is mounted on the rear actuator. It senses the direction and angle of the rear wheels and sends signals to the 4WS control unit. The 4WS control unit uses this information as feedback to determine if the actual rear wheel position matches the desired position.

Front sub steering angle sensor:
The front sub steering angle sensor is mounted on the front steering gearbox. It's purpose is to detect the position of the front wheels and convert this information to an electrical signal for the 4WS control unit.
The front sub steering angle sensor uses a spring loaded plunger that rides in a sloped groove in the rack. As the rack turns the front wheels, the plunger rides up the slope and is pushed into the differential transformer assembly. The plunger's position is used to determine how far the rack is turned.

Rear sub steering angle sensor:
The rear sub steering angle sensor is mounted on the rear actuator spring cover. It detects the position of the rear wheels as a feedback signal for the 4wS control unit. It operates in exactly the same way as the front sub steering angle sensor.

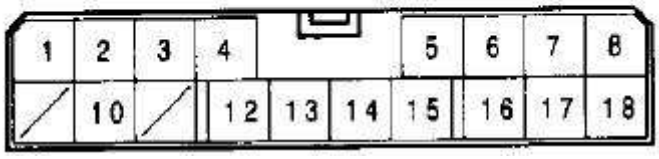
System Flow Chart:


VSS serves the speedmeter as well.
Rear wheel sensors (ABS sensor)
Front main steering angle sensor
Front sub steering angle sensor
Calculation of the car's speed
Calculation of steering rotation speed
Calculation of steering angle for rear wheels
Calculation of motor driving voltage
Power circuit
4WS Control unit
Rear main steering angle sensor
Rear steering actuator (Motor)
Rear sub steering angle sensor

4ws Control Unit Pin Outs:

Connector A

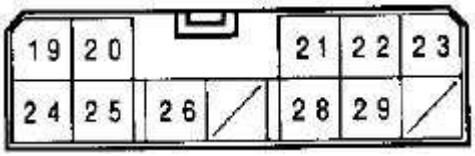
18P CONNECTOR (A)



Conn #----------Wire Color---------Terminal Name
1----------GRY/RED----------Rear right pulse
2----------WHT/BLU----------Charge
3----------GRY/WHT---------Rear left pulse
4----------BLK/YEL----------Ignition 2
5----------RED----------Rear mail steering angle sensor ground
6----------WHT/GRN---------Rear main steering angle sensor A phase
7----------PNK----------Warning 1
8----------GRN----------Front main steering angle sensor A phase
9----------UNUSED----------UNUSED
10----------BRN/WHT---------Service check signal
11----------UNUSED----------UNUSED
12----------BLU----------Front main steering angle sensor Z phase
13----------BLU/GRN---------Rear main steering angle sensor B phase
14----------GRN/RED---------Parking brake
15----------YEL/RED----------Front main steering angle sensor B phase
16----------BLK----------Ground 2
17----------GRY/YEL----------Rear sub steering angle sensor center
18----------WHT/YEL----------Backup power source

Connector B

12P CONNECTOR (B)



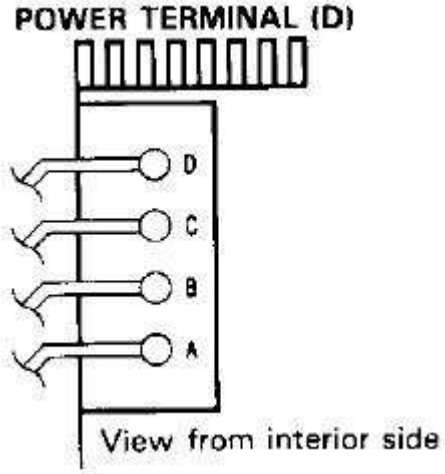
Conn #----------Wire Color----------Terminal Name
19----------ORN----------Vehicle speed sensor
20----------GRN----------Rear main steering ange sensor Z phase
21----------YEL/BLK----------Front sub steering angle sensor left
22----------YEL/BLU----------Front sub steering angle sensor right
23----------PNK----------Warning 2
24----------BLK----------Ground 1
25----------YEL/RED----------Ignition 1
26----------YEL/GRN----------Front sub steering angle sensor center
27----------UNUSED----------UNUSED
28----------GRY/BLK----------Rear sub steering angle sensor left
29----------GRY----------Rear sub steering anble sensor right
30----------UNUSED----------UNUSED

Connector C

4P CONNECTOR (C)

Conn #----------Wire Color---------Terminal Name
31----------UNUSED----------UNUSED
32----------UNUSED----------UNUSED
33----------YEL----------Damper
34----------BLU----------Damper

Connector D



Conn #----------Wire Color---------Terminal Name
A----------WHT----------Motor power source
B----------BRN----------Motor ground
C----------RED----------Motor terminal
D----------BLK----------Motor terminal

Pics of the connectors:

Error Codes:

You pull the 4ws error codes the same way you pull the ECU error codes, just watch the 4ws indicator instead of the CEL. You reset the 4ws control unit the same way as well, pull the 10A radio fuse in the under hood fure box. After resetting the 4ws control unit turn the steering wheel to right lock, then left lock the first time you start the car.
How to pull CEL error codes: http://preludeonline.com/showthread.php?t=131369

Code----------System----------4ws control unit pin #'s----------Affected
10----------Sub steering angle sensor----------22, 26----------Front sub steering angle sensor
11----------Sub steering angle sensor----------29, 17----------Rear sub steering angle sensor
12----------Sub steering angle sensor----------26, 21----------Front sub steering angle sensor
13----------Sub steering angle sensor----------17, 28----------Rear sub steering angle sensor
14----------Sub steering angle sensor----------NA----------4ws control unit
15----------Sub steering angle sensor----------NA----------4ws control unit
16----------Sub steering angle sensor----------22, 26, 21----------Front sub steering angle sensor
17----------Sub steering angle sensor----------29, 17, 28----------Rear sub steering angle sensor
18----------Sub steering angle sensor----------NA----------4ws control unit
20----------Main steering angle sensor---------- 8, 15----------Front sub steering angle sensor, Front main steering angle sensor
21----------Main steering angle sensor---------- 6, 13----------Rear sub steering angle sensor, Rear main steering angle sensor

22----------Main steering angle sensor---------- 8, 15----------Front sub steering angle sensor, Front main steering angle sensor
23----------Main steering angle sensor---------- 6, 13----------Rear sub steering angle sensor, Rear main steering angle sensor
24----------Main steering angle sensor---------- 8, 15----------Front sub steering angle sensor, Front main steering angle sensor
25----------Main steering angle sensor---------- 6, 13----------Rear sub steering angle sensor, Rear main steering angle sensor
26----------Main steering angle sensor---------- NA----------4ws control unit
27----------Main steering angle sensor---------- NA----------4ws control unit
28----------Main steering angle sensor---------- 12----------Front sub steering angle sensor, Front main steering angle sensor
29----------Main steering angle sensor---------- 20----------Rear sub steering angle sensor, Rear main steering angle sensor
30----------Wheel speed----------19----------Front wheel speed sensor
31----------Wheel speed----------3----------Rear left wheel speed sensor
32----------Wheel speed----------1----------Rear right wheel speed sensor
33----------Wheel speed----------3, 1----------ABS control unit, 4ws control unit
34----------Wheel speed----------19----------Front wheel speed sensor
35----------Wheel speed----------3----------Rear left wheel sensor, ABS control unit, 4ws control unit
36----------Wheel speed----------1----------Rear right wheel speed sensor
37----------Wheel speed----------NA----------4ws control unit
38----------Wheel speed----------NA----------4ws control unit
40----------4ws control unit----------NA----------4ws control unit
41----------4ws control unit----------NA----------4ws control unit
42----------4ws control unit----------NA----------4ws control unit
43----------4ws control unit----------NA----------4ws control unit
44----------4ws control unit----------NA----------4ws control unit
45----------4ws control unit----------NA----------4ws control unit
46----------4ws control unit----------NA----------4ws control unit
50----------Control logic----------C+, D- ----------Rear actuator motor
51----------Control logic----------C+, D- ----------Rear actuator motor
60----------Power unit----------C+, D-, 33+, 34- ----------Rear actuator motor, Power system harness
61----------Power unit----------C+, D- ----------Rear actuator motor, Power system harness
62----------Power unit----------33+, 34- ----------Rear actuator motor, Power system harness
63----------Power unit----------NA----------Rear actuator motor, Power system harness
64----------Power unit----------NA----------4ws control unit
65----------Power unit----------NA----------4ws control unit

Temporary Codes:
70 - Ignition is turned from OFF to ON while driving.
71 - The car is driven aggressivly with the driver and three passengers in the car, or the steering wheel is turned with the rear wheel blocked by the curb.
73 - The engine is started while quick-charging the battery
74 - Driving the car with the parking brake ON.

Scans from the service manual:

Troubleshooting (4WS)

Symptom-to-System Chart

DIAGNOSTIC TROUBLE CODE (DTC)	FAIL-SAFE (F/S) ITEM			AFFECTED														ACTION	REFERENCE PAGE
	SYSTEM	POINT	4WS CONTROL UNIT TERMINAL NUMBER	FRONT SUB STEERING ANGLE SENSOR	REAR SUB STEERING ANGLE SENSOR	FRONT MAIN STEERING ANGLE SENSOR	REAR MAIN STEERING ANGLE SENSOR	FRONT WHEEL SPEED SENSOR	REAR LEFT WHEEL SPEED SENSOR	REAR RIGHT WHEEL SPEED SENSOR	ABS CONTROL UNIT	4WS CONTROL UNIT	REAR ACTUATOR MOTOR	POWER SYSTEM HARNESS	ALTERNATOR	PARKING BRAKE	HARNESS CONNECTOR		
No code	—	——	7 + 23									○					○	Go to trouble-shooting	17-42
No code	—	——	18 25 4 2 16 + 24									○			○		○	Go to trouble-shooting	17-42
10	SUB STEERING ANGLE SENSOR	FRONT	22 26	○								○					○	Go to trouble-shooting	17-45
11		REAR	29 17		○							○					○	Go to trouble-shooting	17-50
12		FRONT	26 21	○								○					○	Go to trouble-shooting	17-45
13		REAR	17 28		○							○					○	Go to trouble-shooting	17-50
14		FRONT	——									○						Replace 4WS control unit	—
15		REAR	——									○						Replace 4WS control unit	—
16		FRONT	22 26 21	○								○					○	Go to trouble-shooting	17-45
17		REAR	29 17 28		○							○					○	Go to trouble-shooting	17-50
18		——	——									○						Replace 4WS control unit	—

DIAGNOSTIC TROUBLE CODE (DTC)	FAIL-SAFE (F/S) ITEM			AFFECTED														ACTION	REFERENCE PAGE
	SYSTEM	POINT	4WS CONTROL UNIT TERMINAL NUMBER	FRONT SUB STEERING ANGLE SENSOR	REAR SUB STEERING ANGLE SENSOR	FRONT MAIN STEERING ANGLE SENSOR	REAR MAIN STEERING ANGLE SENSOR	FRONT WHEEL SPEED SENSOR	REAR LEFT WHEEL SPEED SENSOR	REAR RIGHT WHEEL SPEED SENSOR	ABS CONTROL UNIT	4WS CONTROL UNIT	REAR ACTUATOR MOTOR	POWER SYSTEM HARNESS	ALTERNATOR	PARKING BRAKE	HARNESS CONNECTOR		
20	MAIN STEERING ANGLE SENSOR	FRONT	8 15	○		○						○					○	Go to trouble-shooting	17-55
21		REAR	6 13		○		○					○					○	Go to trouble-shooting	17-59
22		FRONT	8 15	○		○						○					○	Go to trouble-shooting	17-55
23		REAR	6 13		○		○					○					○	Go to trouble-shooting	17-59
24		FRONT	8 15	○		○						○					○	Go to trouble-shooting	17-55
25		REAR	6 13		○		○					○					○	Go to trouble-shooting	17-59
26		FRONT	—									○						Replace 4WS control unit	—
27		REAR	—									○						Replace 4WS control unit	—
28		FRONT	12	○		○						○					○	Go to trouble-shooting	17-55
29		REAR	20		○		○					○					○	Go to trouble-shooting	17-59
30	WHEEL SPEED	FRONT	19					○				○					○	Go to trouble-shooting	17-63
31		REAR L	3						○		○	○					○	Go to trouble-shooting	17-64
32		REAR R	1							○	○	○					○	Go to trouble-shooting	17-66

(cont'd)

DIAGNOSTIC TROUBLE CODE (DTC)	FAIL-SAFE (F/S) ITEM			AFFECTED															ACTION	REFERENCE PAGE
	SYSTEM	POINT	4WS CONTROL UNIT TERMINAL NUMBER	FRONT SUB STEERING ANGLE SENSOR	REAR SUB STEERING ANGLE SENSOR	FRONT MAIN STEERING ANGLE SENSOR	REAR MAIN STEERING ANGLE SENSOR	FRONT WHEEL SPEED SENSOR	REAR LEFT WHEEL SPEED SENSOR	REAR RIGHT WHEEL SPEED SENSOR	ABS CONTROL UNIT	4WS CONTROL UNIT	REAR ACTUATOR MOTOR	POWER SYSTEM HARNESS	ALTERNATOR	PARKING BRAKE	HARNESS CONNECTOR		
33	WHEEL SPEED	REAR R/L	3 1								○	○					○	Go to trouble-shooting	17-68
34		FRONT	19					○				○					○	Go to trouble-shooting	17-63
35		REAR L	3						○		○	○						Go to trouble-shooting	17-64
36		REAR R	1							○	○	○					○	Go to trouble-shooting	17-66
37		REAR L	—									○						Replace 4WS control unit	—
38		VEHICLE SPEED	—									○						Replace 4WS control unit	—
40	4WS CONTORL UNIT	4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
41		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
42		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
43		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
44		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
45		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
46		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
50	CONTROL LOGIC	Motor lock	C + D −									○	○				○	Go to trouble-shooting	17-70
51		Wheel caught in ditch. Motor malfunction	C + D −									○	○				○	Go to trouble-shooting	17-71

DIAGNOSTIC TROUBLE CODE (DTC)	FAIL-SAFE (F/S) ITEM			AFFECTED															ACTION	REFERENCE PAGE
	SYSTEM	POINT	4WS CONTROL UNIT TERMINAL NUMBER	FRONT SUB STEERING ANGLE SENSOR	REAR SUB STEERING ANGLE SENSOR	FRONT MAIN STEERING ANGLE SENSOR	REAR MAIN STEERING ANGLE SENSOR	FRONT WHEEL SPEED SENSOR	REAR LEFT WHEEL SPEED SENSOR	REAR RIGHT WHEEL SPEED SENSOR	ABS CONTROL UNIT	4WS CONTROL UNIT	REAR ACTUATOR MOTOR	POWER SYSTEM HARNESS	ALTERNATOR	PARKING BRAKE	HARNESS CONNECTOR		
60	POWER UNIT	MOTOR	C+•D− 33+•34−									○	○	○			○	Go to trouble-shooting	17-71
61			C+•D−									○	○	○			○	Go to trouble-shooting	17-71
62		Motor	33+•34−									○	○	○			○	Go to trouble-shooting	17-71
63												○	○	○			○	Go to trouble-shooting	17-71
64		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
65		4WS CONTROL UNIT	—									○						Replace 4WS control unit	—
70	TEMPORARY DRIVING CONDITIONS	—	25									○					○	Ask customer for symptoms, conditions	—
71		—	—									○						Ask customer for symptoms, conditions	—
72		—	4									○					○	Ask customer for symptoms, conditions	—
73		—										○			○			Ask customer for symptoms, conditions	—
74		—	14									○				○	○	Ask customer for symptoms, conditions	—

Common problems:

1. After you start the car the 4ws light stays on.

Problems: The 4ws light stays on if you kill the car and restart it with 15 - 30 min. You're getting code 60 - 65 from the 4ws system.

Solution: This is probably the most common problem with 4ws. You need to pull the 4ws control unit and resolder the 2 big relays.

Directions: (taken from here: http://honda-tech.com/zeropost?cmd=tshow;id=886363
Directions with pics: http://honda-tech.com/zerothread?id=886363&postid=13217677#13217677

1. Disconnect battery
2. Remove 4WS unit from car (before to get access you have to take off left rear seat and rear moulding inside trunk): disconnect 3 (If I remember well) connectors, 1 or 2 grounds, remove metal cover, and finally remove the unit.
3. Open 4WS unit (6 screws) and carefully put the cover (there is an electronic board connected with one electrical stripe) on the side. I used a big large book to put the cover on and not to brake the stripe. Finally you will have cover on the left side (laying on the book) and open 4WS unit on right side.
4. Remove internal metal cover you will see on the right side (some screws) and take it off.
5. You will see a lot of electronical (and electromechanical) parts inside. There are two black boxes (about 1 cm x 1.5 cm) little under the center of the unit. These boxes are 2 small relays. The problem is there!!! , but on the other side of electronic board, so next step is....
6. Remove the main electronic board from the box: remove all screws that fix the board to the box and other components: I am unable to say you exactly how many of them you have to unscrew - I just don't remember, but you will see yourself what is keeping the board in place. Also it is necessary to unscrew 8 big transistors from box (serving as radiator).
7. When the board is unscrewed, put some protecting paper (ex. newspaper) on the cover board laying on the book and carefully extract the board from aluminum box. Put it on the newspaper with soldering side upper.
8. These 2 relays are soldered 4 or 5 points every of them. These are big soldering. I took a magnifying tool (don't know exact english name - zoom ???) and carefully watching the relays soldering I considered ALL of them were broken.
9. Resolder all relays points and mount the unit.
10. After putting it in the car problem's GONE!!!!

2. More to come.

FAQ

Q. Do I need a 4ws ECU?
A. No! The ECU has nothing to do with the 4ws in a USDM 4th gen prelude.

Q. Can I put 4ws on car X?
A. Sure, you can do anything with time and money but you're probably better off just purchasing a car with 4ws already on it.

Q. Is 4ws only active below X mph?
A. No! It is always active, from a dead stop to top speed.

Resources:
Service Manuals: http://prelude.openbarr.com
All pics and other random stuff can be found here: http://www.simnets.com/gallery2/v/prelude/

Links:

4plug ECU info:
http://www.preludeonline.com/showthread.php?t=143001&highlight=4ws

fix 4th gen 4ws ecu:
http://honda-tech.com/zeropost?cmd=tshow;id=886363

4ws sway bars:
http://www.preludeonline.com/showthread.php?t=180240&highlight=4ws

prelude models:
http://www.preludepower.com/forums/showthread.php?t=229091

2ws to 4ws 3rd gen howto:
http://mustardcat.brinkster.net/p3g/Suspension/2wsto4wsinstall/2wsto4wsinstall.htm

1987 Road and Track 4ws review:
http://www.preludeonline.com/showthread.php?t=209799&highlight=4ws

More to come guys, if anyone has anything they think should be added just let me know!